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Predictors of in-hospital mortality of patients with COVID-19 infection in a major treatment facility in Ghana

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Abstract

Background: An estimated 17 – 18% of hospitalised COVID-19 patients die. This has been attributed to varying symptomatic, prophylactic, patient management and health care factors. However, these factors have been shown to vary with population and setting dynamics. There is limited literature on the impact of these factors on COVID-19 mortality in the Ghanaian setting. This study, therefore, assessed the factors associated with mortality among COVID-19 hospitalised patients.

Objective: The study aimed to assess the clinical and health-related factors associated with the mortality of COVID-19 patients admitted to a major treatment facility in Ghana

Methods: We conducted a retrospective study at Ghana Infectious Disease Center, involving a review of data collected on patients admitted to the facility from January 2021 to December 2021. Using a data abstraction tool on KoboCollect, data on patient sociodemographic characteristics, clinical presentation, underlying conditions and vaccination status were extracted from patient folders and other inpatient registers. We analysed the data and estimated Odds ratios and their respective 95%CI intervals.

Results: Out of the 271 patients admitted to the hospital within the study period, 8.86% (95% CI: 5.76 – 12.89) died. Being diabetic (aOR = 2.62, 95% CI: 1.08 - 6.35), having a cardiovascular-related disease (aOR = 4.06, 95% CI: 1.03 – 15.91), having a kidney disease (aOR = 4.56, 95% CI: 1.40 - 14.92), a chronic lung disease (aOR = 4.42, 95% CI: 1.45 - 13.53), and longer duration of admission (aOR = 1.06, 95% CI: 1.01 - 1.11) were associated with increased odds of death among the patients. Being vaccinated (aOR = 0.40, 95% CI: 0.11 - 0.49) was associated with a reduction in the odds of death among the patients.

Conclusion: This study revealed a less than 10% mortality rate among the patients. Being unvaccinated, having an underlying condition (diabetes, cardiovascular-related diseases, chronic lung diseases and kidney disease) and having a longer duration of admission in the hospital were associated with increased risk of death among the patients.

Keywords: COVID-19, SARS-CoV-2, mortality, inpatient, vaccination, Ghana Infectious Disease Centre

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INTRODUCTION

On 5th January 2020, the World Health Organisation (WHO) published an outbreak of a novel coronavirus strain, Corona Virus Disease 2019 (COVID-19) and later shared the genetic sequence of its causative pathogen, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV-2), on 12th January 2020 [1]. The exponential growth of the outbreak led to the WHO's declaration of a pandemic on 11th March 2020 [2]. Despite efforts to prevent the infection and its related severity and

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mortality by sensitisation and awareness creation, vaccination efforts through the COVID-19 Vaccines Global Access (COVAX) initiative, adherence to precautionary measures, surveillance and treatment measures, COVID-19 is yet to be totally eradicated [3,4]. As of 30th November 2022, over 619 million COVID-19 infections have resulted in over 6 million deaths worldwide [5]. There have been about 12.7 million cases in Africa and 256,000 deaths as of 30th November 2022 [6]. There have been reports of about 171 thousand cases and almost 1.5 thousand deaths (a case fatality rate of 0.86%) in Ghana as of 30th November 2022 [7]. Mortality from COVID-19 continues to cause economic, social and public health interferences, affecting livelihoods, family structure, food security, employment and labour issues and loss of income [8–10]. Studies in other parts of the world have shown that in-hospital mortality rates due to COVID-19 have been estimated to be about 17 – 18% of hospital admissions, attributed to varying symptomatic, prognostic assessment, hospitalisation characteristics, prophylactic, patient management and healthcare factors [11,12]. These factors have, however, been shown to vary with population and setting dynamics, and hence, identified gaps in the documentation of factors that influence in-hospital mortality in Ghana require attention [13]. Also, there is a probable risk of persistence in COVID-19 mortality in Ghana, with in-hospital mortality contributing the greater part due to inadequate knowledge and poor application of knowledge to control factors that exacerbate COVID-19 mortality in the country. Hence, this study aimed to assess the clinical and health-related factors associated with the mortality of COVID-19 patients admitted to a major treatment facility in Ghana.

MATERIALS AND METHODS

Study design and sites

The study was conducted at the Ghana Infectious Disease Center (GIDC), the first purpose-built infectious disease facility to be established in the country, which served as a National Case Management Coordinating Treatment Centre for the clinical management of COVID-19 in 2021 and 2022 and eventually, other infectious diseases. The GIDC, situated in the Ga East Municipality of the Greater Accra Region of the country, runs an Infectious Disease Outpatient Department (OPD) and a Post-COVID-19 Clinic and has a 100-bed capacity to admit patients to its High Dependency Unit (HDU) and Intensive Care Units (ICU). The centre has an infectious disease specialist, an anesthesiologist/intensivist, 15 medical officers, 40 nurses and 13 laboratory personnel as part of its clinical service delivery cadre. The GIDC was operationalised on 10th January 2021; as of May 2022, 1004 walk-in (OPD) cases and 317 admissions had been attended to at the treatment centre.

Sample size and sampling technique

We conducted a retrospective study at the GIDC involving a review of data collected on patients admitted to the facility from January 2021 to December 2021. Data on COVID-19 patients admitted to the wards in the GIDC (both HDCU and ICU) from January 2021 to December 2021 was extracted from patient folders using a digital abstraction form on the KoboCollect version 2021.2.4 platform. The outcome variable that was measured in this study was in-hospital mortality. In-hospital mortality was defined as the discharge of hospitalised patients on the basis of confirmed clinical death. Independent variables extracted for analysis comprised demographic information (age, sex, occupation, marital status and residence), epidemiologic information (travel history, epidemiological links), clinical information (vital signs, underlying conditions, symptoms, case management information, hospital service rendered (HDU or ICU), length of hospital stay, vaccination status and treatment outcome. Cases were classified as mild, moderate, severe or critical based on the WHO criteria for classifying COVID-19 cases at the time of initial presentation, no matter the change in presentation later on. Vaccinated patients were defined as those who had received any dose of any COVID-19 vaccine series, and unvaccinated patients were those with no series of any COVID-19 vaccine. Fully vaccinated patients had completed the full series of any COVID-19 vaccine schedules at least seven days before hospitalisation, and partially vaccinated were those with incomplete series of any COVID-19 vaccine schedules. A patient with one or more heart and blood vessel diseases, including high blood pressure, low blood pressure, coronary artery disease, congestive heart failure, arrhythmia, peripheral artery disease, and congenital heart disease, was noted to have a cardiovascular-related disease. Obesity was defined as a BMI that is equal to or higher than 30.0, with the measurement for severe or critical patients extracted from referral letters. Diabetes was defined as a chronic metabolic disorder characterised by persistent hyperglycemia. Kidney disease was defined as a decrease in kidney function shown by glomerular filtration rate (GFR) of less than 60 mL/min per 1·73 m^2, or markers of kidney damage, or both, of at least three months duration, regardless of the underlying cause. An individual with any inherited red blood cell disorders, including HbSS, HbSC, HbS beta thalassemia, HbSE, HbSO and HbSD, was noted to have sickle cell. Chronic lung disease was defined as any long-term disease in the lungs leading to a reduction in airflow and breathing-related problems.

Data analysis

The data extracted were cleaned and imported into Stata 15 (StataCorp, College Station, TX, USA) for analysis. Categorical variables were expressed as frequencies and percentages with their corresponding 95% CI. Parametric continuous variables were expressed as means and standard deviation. The Chi-square test of association was used to compare the clinical characteristics of the vaccinated and unvaccinated patients. Binary logistic regression analysis was performed to test the association between in-hospital mortality and the various characteristics. Variables that

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were significant at a p-value < 0.25 at the unadjusted level were selected and fitted into an adjusted logistic model. The level of significance for the final model was set at 5%.

RESULTS

Characteristics of the patients

The study included 271 COVID-19 patients who were admitted to GIDC. Out of the 271 patients, 8.86% (n = 24) died. Regarding the patients' background characteristics, more than half (53.51%, n = 145) were males. The median age of the patients was 56.0 years, with an interquartile range of 38.0 – 66.0 years. About two-fifths (40.59%, n = 110) of the patients had underlying comorbidities. On the vaccination status, type and completion among the patients, less than 20% (17.71%, n = 48) were vaccinated against COVID-19. Of the total patients vaccinated, 70.83% (n = 34/48) had completed their vaccine doses. The majority (47.92%, n = 23) of the vaccinated patients received the AstraZeneca vaccine (Table 1).

Distribution of Comorbidities among the patients studied

Six comorbid conditions were recorded among the patients admitted. More than half (52.77%, n = 143) of the patients had cardiovascular-related diseases. Almost 9% (8.86%, n = 24) of the patients were obese. Less than a fifth (14.39%, n = 39/271) of the patients had kidney-related diseases (Table 2).

Association between disease outcome and clinical presentation among COVID-19 Patients

A multivariate logistic regression analysis revealed a statistically significant association between vaccination status, length of hospitalisation, presence of underlying conditions and the disease outcome. More than 10% (10.76%; n = 24) of the unvaccinated patients died compared to zero fatality recorded among the patients vaccinated against COVID-19. The study revealed 60% reduced odds of dying among patients vaccinated compared to the unvaccinated patients (aOR = 0.40, 95% CI: 0.11 - 0.49). On the length of stay in the hospital, the survivors had a median stay period of 7.0 days (IQR 5.0 - 10.0), whiles the non-survivors had a median stay period of 9.0 days (IQR: 5.5 - 15.5). A unit increase in the number of days spent on admission was associated with a 6% increase in the odds of dying among the patients admitted (aOR = 1.06, 95% CI: 1.01 - 1.11) (Table 3).

Association between disease outcome and comorbidities among COVID-19 patient

Multivariate logistic regression analysis further revealed a statistically significant association between specific comorbidities (cardiovascular-related diseases, diabetes, kidney disease, chronic lung disease and sickle cell) and the management outcome among the patients. The patients who had died from diabetes were 18.03% (n = 11) compared to 6.37% (n = 13) of the patients who were not diabetic. The study revealed 2.62 times increased odds of dying among diabetics compared to non-diabetics (aOR = 2.62, 95% CI:

Table 1: Characteristics of study participants

Characteristics	Frequency (n = 271)	Percentage (%)
Sex		
Female	126	46.49
Male	145	53.51
Age (median; IQR) years	56 (38.0 – 66.0)	
<25 years	18	6.64
25 – 34 years	32	11.81
35 – 44 years	43	15.87
45 – 54 years	36	13.28
55+ years	142	52.40
Co-morbidity		
No	161	59.41
Yes	110	40.59
Hospitalization care		
HDU	225	83.03
ICU	46	16.97
Severity of disease		
Mild	69	25.46
Moderate	67	24.72
Severe/Critical	135	49.82
Length of Hospitalization (days)	7.0 (5.0 – 11.0)	
Treatment outcome		
Alive	247	91.14
Dead	24	8.86
Vaccination status		
Unvaccinated	223	82.29
Vaccinated	48	17.71
Vaccination completion		
Partial	14	29.17
Complete	34	70.83
Type of vaccine		
AstraZeneca	23	47.92
J&J	10	20.83
Pfizer	15	31.25

Table 2: Distribution of comorbidities among the patients studied

Comorbidities	Frequency (N = 271)	Proportion (%)
Cardiovascular related diseases		
No	128	47.23
Yes	143	52.77
Obesity		
No	247	91.14
Yes	24	8.86
Diabetes		
No	204	75.28
Yes	67	24.72
Kidney disease		
No	232	85.61
Yes	39	14.39
Sickle cell		
No	219	80.81
Yes	52	19.19
Chronic lung disease		
No	202	74.54
Yes	69	25.46

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Table 3: Association between disease outcome and clinical presentation among COVID-19 patients

Variables	Alive n (%)	Dead n (%)	cOR (95%CI)	aOR (95%CI)
Vaccination				
Unvaccinated	119 (89.24)	24 (10.76)	Ref	Ref
Vaccinated	48 (100.00)	0	0.45(0.13 1.62)	0.40 (0.11 0.49) **
Disease severity				
Mild	62 (89.86)	7 (10.14)	Ref	Ref
Moderate	63 (94.03)	4 (5.97)	0.56 (0.16 2.02)	0.61 (0.16 2.30)
Severe/Critical	122 (90.37)	13 (9.63)	0.94 (0.36 2.49)	0.88 (0.32 2.42)
Length of hospitalization (days)	7 (5.0 – 10.0)	9 (5.5 - 15.5)	1.06 (1.01 1.11)	1.06 (1.01 1.11) **
Co-morbidity				
No	157 (97.52)	4 (2.48)	Ref	Ref
Yes	90 (81.82)	20 (18.18)	8.72 (2.89 26.31)	6.85 (2.06 22.71) **

Table 4: Association between disease outcome and comorbidities among COVID-19 patients

Variables	Alive n (%)	Dead n (%)	cOR (95%CI)	aOR (95%CI)
Cardiovascular related diseases				
No	32 (91.43)	3 (2.34)	Ref	Ref
Yes	112 (85.31)	21 (14.69)	7.17 (2.09 - 24.66)	4.06 (1.03 - 15.91) **
Obesity				
No	228 (92.31)	19 (7.69)	Ref	Ref
Yes	19 (79.17)	5 (20.83)	3.16 (1.06 - 9.39)	2.79 (0.76 - 10.20)
Diabetes				
No	191 (93.63)	13 (6.37)	Ref	Ref
Yes	50 (81.97)	11 (18.03)	2.89 (1.23 - 6.79)	2.62 (1.08 - 6.35) **
Kidney disease				
No	218 (93.97)	14 (6.03)	Ref	Ref
Yes	29 (74.36)	10 (25.64)	5.37 (2.18 - 13.19)	4.56 (1.40 - 14.92) **
Sickle cell				
No	208 (94.98)	11 (5.02)	Ref	Ref
Yes	39 (75.00)	13 (25.00)	6.30 (2.63 - 15.08)	5.52 (1.53 - 20.00) **
Chronic lung disease				
No	193 (95.54)	9 (4.46)	Ref	Ref
Yes	54 (78.26)	15 (21.74)	5.96 (2.47 - 14.35)	4.42 (1.45 - 13.53) **

1.08 - 6.35). On the distribution of kidney diseases among the patients, 25.64% (n = 10/39) of the patients with known kidney diseases died compared to 6.03% (n = 14/232) of those without kidney diseases. The study revealed fourfold increased odds of dying among those with kidney disease as compared to those without kidney disease (aOR = 4.56, 95% CI: 1.40 - 14.92). Regarding chronic lung diseases, 21.74% (n = 15/69) of the patients with known chronic lung diseases died. Patients with chronic lung diseases had four times more odds of dying than their counterparts (aOR = 4.42, 95%CI: 1.45 - 13.53) (Table 4).

DISCUSSION

Our study aimed at assessing the factors associated with the mortality of COVID-19 patients admitted to a major treatment facility in Ghana. In this study, we observed a mortality rate of almost 9% among the patients. The mortality rate recorded in this study is lower than the mortality rate of 34.4% reported in another Ghanaian study and lower than the mortality rate reported in a similar Peru study where 46.6% of the patients died [9,14]. Similarly, a study conducted in Jordan reported more than 30% mortality rates among hospitalised patients [15]. In another study conducted at Kinshasa University Hospital among COVID-19 patients, a 43.7% mortality rate was recorded [16]. The mortality disparity seen between our study and these other studies may partly be due to the fact that the GIDC is a purpose-built infectious disease health facility which, during the period of this study, was solely focused on the clinical management of COVID-19 by the National coordinating team compared to these other centres which were pre-existing health facilities combining COVID-19-related and non-COVID-19-related health care delivery. There is, therefore, likely to have been better resource (human, diagnostic and material) availability accessible to GIDC compared to the other facilities with much higher mortality from COVID-19. Also, disparities in the average age of patients, vaccination status and timing of the study

could have accounted for the higher mortality rate seen in these previous studies compared to our study. The average age of patients in our study was 56 years, with a more than 17% vaccination rate compared to the over 60 years average age and zero vaccination rates in these previous studies. Unlike our study, these studies were conducted prior to full vaccine deployment to the entire population in the study settings. Attributing the higher mortality rate in these studies to age and vaccination status is further substantiated by studies reporting higher mortality rates among advanced-age patients and the unvaccinated population [11,17,18].

Vaccination is one of the public health measures deployed globally to prevent the spread and control of COVID-19. COVID-19 vaccines have been reported to be associated with a reduction in the risk of severe disease and death among patients with the disease [19-22]. This study revealed an increase in the risk of mortality among the unvaccinated compared to the vaccinated patients. This is consistent with the findings of studies conducted in China, Peru, the USA and Germany, which reported a more than 30% decrease in the risk of severe disease and death among vaccinated COVID-19 patients [3,4,22]. In a study by Perazzo et al. (2022), COVID-19 vaccination was associated with a 53% reduction in the risk of death among hospitalised patients compared to their counterparts. This implies that to reduce the mortality associated with COVID-19 among hospitalised patients in Ghana more efforts should be adopted to increase COVID-19 vaccination coverage among the populace. Healthcare workers, particularly in COVID-19 treatment facilities and centres, should endeavour to encourage all patients seen to get vaccinated. Also, HCWs in treatment centres, especially those in post-COVID-19 clinics, should encourage all patients who prior to contracting COVID-19, had not been vaccinated to do so once its practicable post-recovery. Government institutions such as schools, hospitals, all executive and parliamentary offices and all public service institutions should adopt mandatory COVID-19 vaccination policies among their employees.

Our study also identified an association between the presence of underlying conditions and the odds of death among the patients. Patients with comorbid conditions were at increased risk of death compared to those without underlying health conditions. This could be due to a possible increase in systemic inflammation, weakened immune system, lung harm, slow recovery and risk of hospitalisation that are presented with these comorbidities before a patient is infected with COVID-19 and further during COVID-19 morbidity [17,23]. These conditions further aggravate the COVID-19 presentation and, hence, severity and resulting mortality. This has been reported by numerous studies conducted in different parts of the world [21,24-26]. Regarding the association between particular comorbidities and the risk of death among the patients studied, our study revealed an increased risk among patients with cardiovascular-related diseases, diabetes, kidney diseases, chronic lung diseases and sickle cell disease. Patients who were known diabetics had more than three times the risk of death compared to their counterparts. This is consistent with the results reported by Baguma et al., where diabetics had nine times increased risk of death compared to non-diabetics. Also, in a study conducted by Karasneh et al., diabetics had a 59% increased risk of dying compared to their counterparts. Being diabetic and contracting COVID-19 portends grave consequences. Active case finding through a symptom screening tool akin to the one employed for tuberculosis needs to be adopted by HCWs in diabetic clinics to help identify diabetics at risk of COVID-19. Also, screening using Antigen testing at diabetic clinics may well increase the likelihood of identifying diabetics with COVID-19, which will warrant early initiation of appropriate care. In addition to others, these measures may help reduce the mortality associated with co-infection with diabetes. Patients with cardiovascular-related comorbidities also had an increased risk of mortality in this study compared to their counterparts. This finding has been substantiated by various studies where cardiovascular diseases such as hypertension, deep vein thrombosis and heart failure were reported to be positively associated with the risk of death among COVID-19 patients [10,28]. In a study conducted at Xinhua Hospital of Hubei Province, China, COVID-19 patients with hypertension had an increased risk of death compared to their counterparts [29]. Other underlying conditions that we found to influence the risk of death among the patients were chronic lung disease and kidney disease. Patients with chronic lung diseases had more than three times higher risk of death than their counterparts. This is consistent with the reports of the WHO and other cohort studies, such as the WHO COVID-19 report of the People's Republic of China, which indicated that recorded deaths were generally people with advanced age or comorbid conditions, including chronic lung diseases [30]. In a prospective cohort study conducted among COVID-19 patients with chronic lung diseases such as Chronic Obstructive Pulmonary Disease (COPD), lung cancer and interstitial lung diseases (ILDs) and those without chronic lung diseases, it was determined that patients with chronic lung disease had a 25.76% higher mortality risk [31]. To reduce the risk of death among these patients, health workers must consider the underlying COPD when treating COVID-19 in COPD patients. Also, COVID-19 patients with known chronic lung diseases should be monitored for respiratory decompensation, other infections (pneumonia, urinary tract infection) and thromboembolic events as recommended by Olschewski et al.. Tuberculosis is quite endemic in Ghana and constitutes one of the major causes of Chronic lung diseases. It will be prudent that bi-directional testing for Tuberculosis and COVID-19 is institutionalised in TB and respiratory clinics. This will help identify patients with underlying Chronic lung disease whose exacerbations may have been as a result of COVID-19; the findings from this study will lead to prioritisation of their management and the options available for care.

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The length of stay in the hospital was another factor revealed to be associated with mortality from COVID-19 among hospitalised patients in this study. Patients who spent more days in the hospital had an increased mortality risk compared to those who spent fewer days. This is consistent with the results of a similar study conducted in Brazil, where the length of hospitalisation was a significant factor for the clinical outcome of death ($P < 0.001$), with a 2-fold greater chance for patients hospitalised for more than 14 days dying [32]. The finding is inconsistent with the results of a similar study conducted in Ghana that reported a shorter length of stay among patients who died compared to those who survived.

The study, however, did not explore an association between the number of days spent in the hospital and the risk of death [33]. Our study used data collected in the inpatient folders of the patients seen in the facility. The unavailability of data on laboratory investigations and other biological parameters made it difficult to explore the association between these parameters and the mortality risk in this study. Though the use of data from a single facility in this study and some wide confidence intervals could be a limitation for the generalisation of our findings, this centre is currently the only infectious disease centre in the country and receives referrals from other treatment centres. We recommend further studies conducted in this area should explore the association between laboratory findings, treatment modalities and the outcome of the disease among COVID-19 inpatients.

Conclusion

This study revealed a less than 10% mortality rate among the patients. Being unvaccinated, having an underlying condition (diabetes, cardiovascular-related diseases, chronic lung diseases, sickle cell and kidney disease) and having a longer duration of admission in the hospital were associated with increased risk of death among the patients. Health and other public institutions should be encouraged to adopt a mandatory COVID-19 vaccination policy among employees. In addition, HCWs in chronic care clinics need to adopt innovative strategies to rapidly identify patients at risk of COVID-19 through the use of screening algorithms and rapid Antigen testing methods.

DECLARATIONS

Ethical considerations

Ethical clearance for this study was sought from the Ghana Health Service Ethics Review Committee (GHS-ERC 006/05/20). Administrative approval was formally obtained from the administration of the GIDC. Codes were generated and used in place of personal identifiers of patients to ensure patient anonymity and preserve confidentiality during data abstraction and analysis.

Consent to publish

All authors agreed to the content of the final paper.

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None

Competing Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Author contributions

All authors were involved in conceptualising and designing the study. Data was curated by GG, and AGM. Data was analysed by GG, AGM and DB. The initial manuscript was drafted by GG and AGM, but all authors made significant intellectual contributions leading to the final manuscript. All authors read and approved the final manuscript.

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Availability of data

The datasets generated during and/or analysed during the current study are available from the corresponding author upon reasonable request.

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